KEENE

Mechanics of the Household

Mechanical Engineering

M. E.

1912

MECHANICS OF THE HOUSEHOLD

E. S. KEENE

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With the present day improvements in the heating and lighting of dwellings and the perfected systems of water supply, the comforts of country and suburban residences may be made as complete as could be obtained in cities. There is however, one problem of sanitation - that of sewage disposal- which has received much serious attention but has not yet been completely solved. Unless the natural surroundings are such as will permit sewage to be emptied into a stream of considerable volume the question of its safe disposal becomes one of serious importance. Some method of sewage disposal is an absolute necessity to the isolated dwelling if the occupants are to enjoy the benefits of modern conveniences and at the same time guard against the possibility of disease.

An adequate system of sewage disposal may often have more to do with the health and happiness of a community than an abundant food supply. The safe disposal of waste matter of the household wards off disease and death. When people fully realize the opportunity for the development and transmission of disease in the form of household sewage, much greater attention will be given to its safe disposal. Where no special effort is made for disposing of household waste, the putrifaction that must take place in its natural decomposition gives rise to odors, health destroying vapors and may provide a breeding place for a multitude of disease producing germs that may be blown through the air, transmitted by flies and other insects or carried through the soil by the water. If the drainage should

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happen to be toward a source of drinking water, disease may be scattered broadcast from a cause that could readily be prevented.

The benefits of good food and fresh air of the country are often more than counterbalanced by a contaminated water supply, which might be prevented. Good water and the destruction of the harmful properties of sewage are vitally necessary to the health of any community. It is largely on account of one or both of these two factors that the percentages of mortality in rural communities are often higher than that of cities.

The successful disposal of sewage from cities is accomplished under a great varity of conditions. It is much easier to arrange for sewage purification on a large scale than in a small way. The reason for this is that in the case of a city the plant is under the care of a competent person whose business it is to see that the conditions are kept at the highest efficiency. Private plants are left almost entirely without care until they fail from causes that are usually preventable. Sewage may be successfully purified under almost any conditions, but no type of plant has as yet proven itself successful that does not receive intelligent attention.

One means that promises a solution to the problem of small sewage disposal plants is that of the septic tank,,in connection with any adequate form of bacterial filter. Cesspools are not to be countenanced by people of intelligence. The cesspool has been so universally condemned by authorities that it is needless to tell intelligent people to look upon it as a [illegible]. Although the septic tank is little more than an improved cesspool, the conditions under which it acts [illegible]

disposal and with care and attention it may be made to work to a degree of perfection that is surprising. The one great cause of the failure of small sewage disposal plants is the difficulty and lack of proper care.

The process of sewage purification as now practised in the most successful plants is largely mechanical but bacterial action, plays a part of great importance in the completion of the process. It consists of two stages - the tank treatment in which the sewage is liquified, and the process of filtration where the liquified sewage - commonly called the effluent - from the septic tank undergoes a process of filtration and bacterial purification.

THE SEPTIC TANK.

The sewage is first collected in a tank of sufficient size to contain the discharge from the house for 24 hours. In this process of liquation the sewage is rendered almost entirely liquid, at the same time it has been acted upon by the bacteria that are developed and that tend to reduce the sewage to its elemental form. The effluent liquid which passes out of the tank is almost colorless and ~~[illegible]~~ possesses relatively little odor. It then goes into a filter bed, composed of gravel or other loose material where it undergoes still further bacterial action and if the process is complete, the water which comes from the filter bed is clear and odorless. Under good conditions it is clear sparkling water containing but a small amount of impurities.

The first septic tanks to be used were of a type that is illustrated in Figures 1, and 2. In Figure 1, the tank is shown in position to receive the sewage from the house drain,

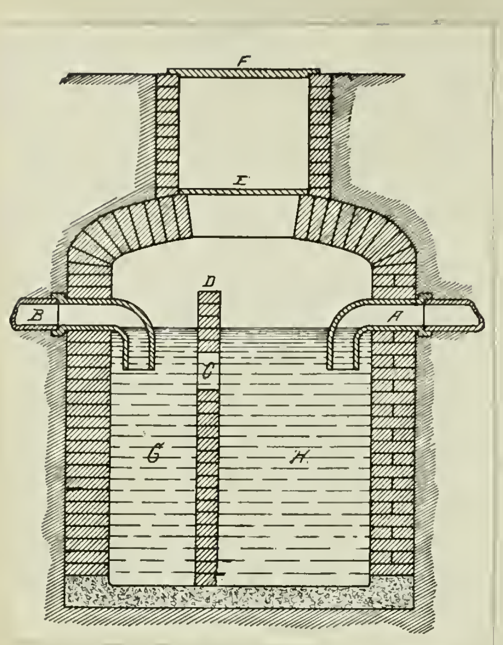


FIG. 2.

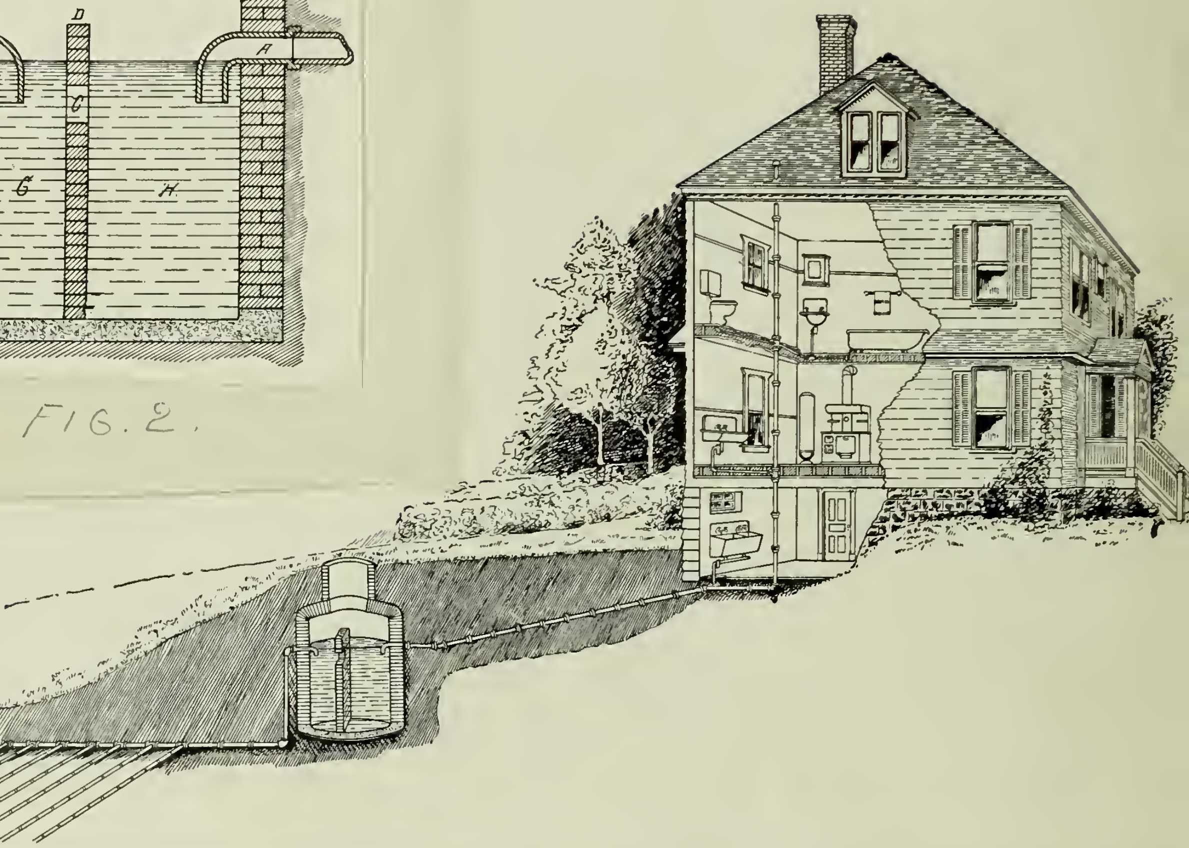


FIG. 1.

where it is to undergo the first treatment and then to be conducted to a filter bed made of porous tile, set in loose soil, preferably [illegible]. The tank is shown in detail in figure 2. It is a cemented-brick cistern with an opening to the surface that contains a double cover as a protection during cold weather. A brick partition divides the tank into spaces A, and B, that contain volumes that are to each other as 1 to 2. The tank is of such size as will hold a volume of sewage equal to 24 hours use; that is, it is expected that any portion of sewage will remain in the tank for that length of time. The sewage enters at A, in such a way as will give the least disturbance to the liquid of the tank. An opening C. allows the liquid to pass from A, into B, where any additional sewage entering A, will discharge an equal amount in C, which will pass out at E, to the filter bed. The partition D, is high enough so that the scum that forms on the surface will not pass directly into the space B. The entrance and exit pipes are made of vitrified sewer tile with the openings below the surface.

As the sewage enters the first tank, a considerable portion will sink to the bottom, while some will float to the top where a considerable scum will gather. By far the greatest portion of the solids will be readily dissolved in the water and the remainder will be rapidly further reduced to liquid form by bacterial solution. The process of disintegration that goes on evolves a considerable amount of carbon dioxide and ammonia which filters through the scum. The process that now goes on in the tank is that of liquifying the organic matter and changing it from organic to the inorganic state. The residue that is found at the bottom

of the tank is a black powder substance that is called sludge and in composition is largely humus. This tank must be occasionally cleaned, probably twice a year. The amount of accumulated matter is relatively small and the operation of cleaning is not so disagreeable as might be supposed.

The bacteriologist recognizes in the process of sewage disintegration the work of two classes of bacteria, the aerobic or those bacteria that work by reason of air and do their work only in its presence and the anaerobic or those that work in the absence of air. In the design of the sewage disposal plant both kinds of bacteria are at work. If in the final stage [illegible] the sewage passes into the filter, air [illegible] carried into [illegible] the action will be destroyed.

It is evident that since the sewage entering the tank is almost entirely dissolved that under ideal action this system would give very little trouble, but actually as the sewage enters the tank the disturbance caused by the incoming water forces some of the undigested matter into the outlet and being carried into the filter bed it will be deposited at the first opportunity. This will cause the filter bed to fill up with undigested sewage at the point nearest the entrance and in the course of time it will stop the pipe because of this accumulation.

To avoid such an occurrence, tanks have been built in which an automatic siphon discharges a part of the effluent after a certain quantity has collected. Such a tank is shown in figure [illegible]. With this arrangement the sewage enters the first tank A, and passes into the second tank [illegible]. [illegible] at B, is shown [illegible] automatic

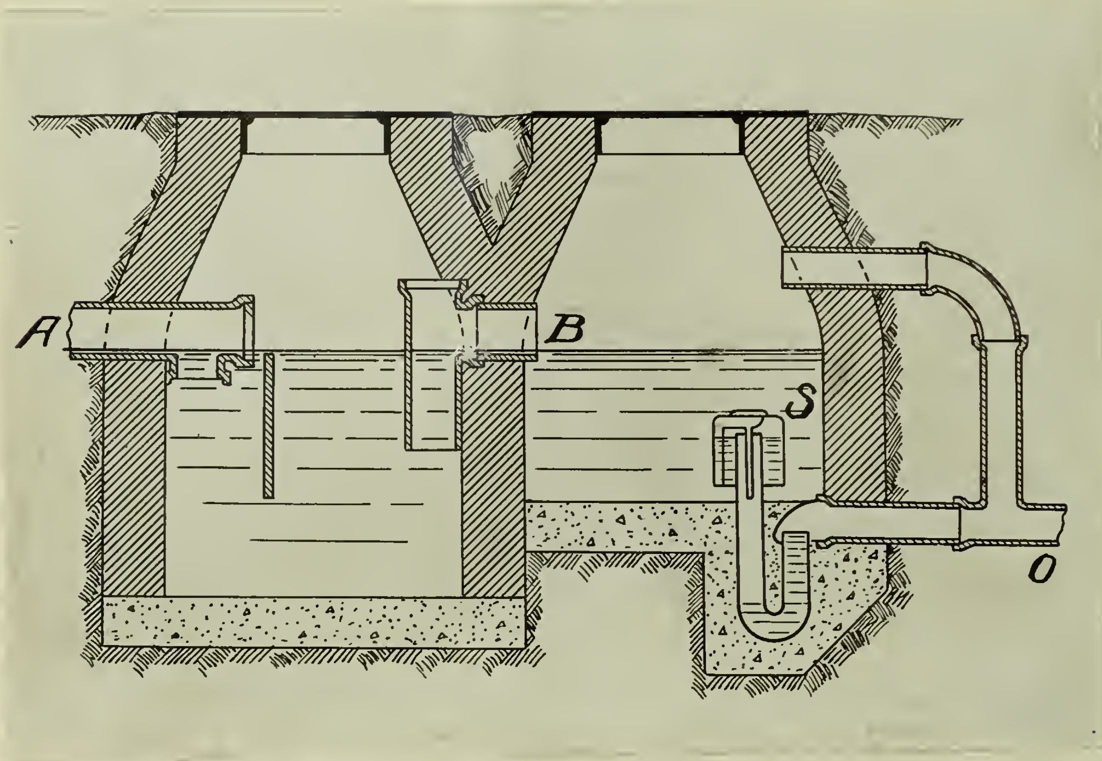
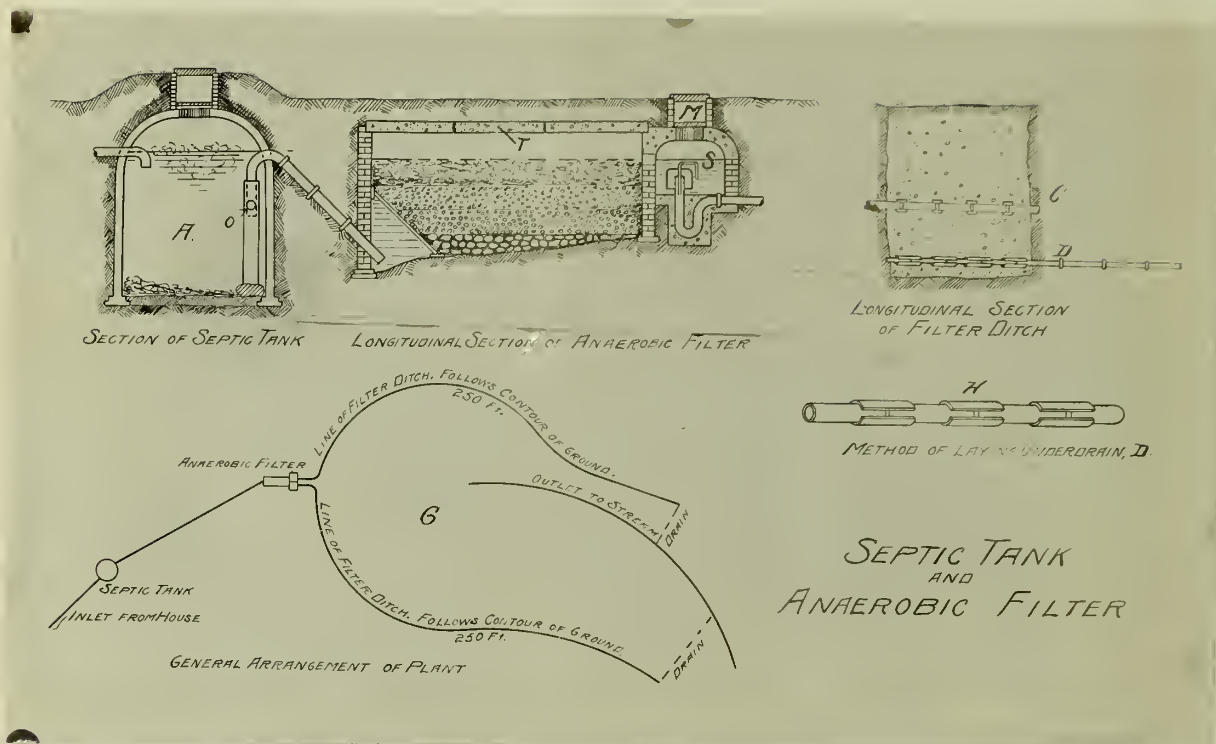


FIG. 3.

siphon is made to discharge the effluent has collected to the height of the siphon line, the siphon automatically discharges the contents of the tank. This is known as a dosing tank and once periodically, a dose of the effluent is discharged into the filter bed. The volume discharged is sufficient to fill the [illegible] portion of the bed, and forces out the air in the loose soil. As the water filters from the bed the air is drawn in to take its place and enables the bacteria which work in the presence of air an opportunity to do their work. The work done in the filter bed is first to filter out any suspended matter carried in the effluent which will lodge on the surfaces of the filter material and then to undergo the slow process of nitrification, and to permit the oxidation of the dissolved sewage. If this matter is deposited faster than it is disintegrated then the filter will fill up and finally refuse to work.

[illegible] WITH FILTER DITCH.

Still another type of sewage plant is shown in Figure 4. This arrangement is not so complete as the preceding because of the use of the anaerobic filter in which opportunity is given for the disintegration that is brought about by the anaerobic bacterial action. The water which is discharged from it is clear and practically odorless. This water is still further purified by passing through a filter ditch, a section of which is shown in the figure. The water is finally drained into a stream as indicated in the general plan. The liquid coming from the filter ditch of a properly proportioned plant of this type is practically pure water.



M
T
S
A.
O
C
D
SECTION OF SEPTIC TANK
LONGITUDINAL SECTION OF ANAEROBIC FILTER
LONGITUDINAL SECTION
OF FILTER DITCH
H
METHOD OF LAYING UNDERDRAIN, D
LINE OF FILTER DITCH. FOLLOWS CONTOUR OF GROUND.
250 FT.
ANAEROBIC FILTER
G
OUTLET TO STREAM
DRAIN
SEPTIC TANK
INLET FROM HOUSE
LINE OF FILTER DITCH. FOLLOWS CONTOUR OF GROUND
250 FT.
GENERAL ARRANGEMENT OF PLANT
SEPTIC TANK
AND
ANAEROBIC FILTER

FIG. 4.

The septic tank in Figure 4, is quite similar in construction to the others described except that a section of sewer tile takes the place of the brick wall between the two parts of the tank. The opening, through which the effluent is discharged, is located a little above the center of the tank.

The anaerobic filter is a tank, rectangular in cross section, made with brick walls and cemented on the inside. The effluent from the septic tank enters the anaerobic in a chamber L, that is separated from the main tank by a wooden partition, against which rests the filling material. As indicated on the drawing, the bottom is filled with coarse material, stones or broken tiles about four inches in diameter. Above this is a layer of material about two inches in diameter, and above that another layer of 1 inch material. This forms the anaerobic filter in which takes place the bacterial action away from the presence of air. The interspaces in the filling allows the effluent from the septic tank to gradually seep through and deposit the particles of matter held in suspension. The arrangement is [illegible] suited to the anaerobic action. It is evident that part of the matter that [illegible] in the septic tank and [illegible] removed as sludge will be carried into the anaerobic filter. This will, of course form an insoluble deposit that will accumulate and in the course of time the filter will become clogged. It should be expected that such a filter will ultimately need renewal, for this reason the top is made of slabs of reinforced concrete that they may be raised to allow the removal and refilling of the filter material.

The automatic siphon discharges the water from the chamber C, whenever it is filled. The discharged water from the siphon is conducted into a drain tile, placed in a ditch filled with gravel or other loose material which serves as an additional filter and in which the water undergoes still further purification. This filter ditch is constructed as indicated in the longitudinal section. The water from the siphon enters the tile C, and seeping through the filling is drained away in the tile shown at D.

The tiles are not set close together but the joints are left open and covered by pieces of broken tile as shown in A. This is to prevent the trench filling from entering the tile and thus stopping the ready flow of the water.

The filter ditch will be constructed according to the contour of the ground and will follow the natural drainage. A general plan for such a filter is shown in B, in which are located the septic tank and the anaerobic filter. The course of the ditch will accommodate itself to the character of the ground. The final discharge of the water generally will be into a stream. The final effluent from the filter ditch will be sparkling water that is practically pure.

That a plant of this kind will work perfectly when new is beyond a doubt but that it will continue indefinitely to give perfect satisfaction is not reasonable to expect. The septic tank will require cleaning probably twice a year. The anaerobic filter will require renewing at intervals, depending on the amount of sewage the filter is required to take care

of and the rate at which the plant is worked. If the septic plant should be small and not able to readily take care of the sewage, the amount of accumulation in the anaerobic filter will be greater than from a septic tank of sufficient size.

It would only be reasonable to suppose that the siphon will some time refuse to discharge. Even though it is an automatic siphon, circumstances may cause it at times to refuse to act. For this reason the manhole is placed so that the siphon may be readily inspected. Again, the tiles in the filter ditch may at times become stopped and have to be relaid. It must not be supposed that once such a plant is in place that most of the work is over. The success of xx a good sewage disposal plant of this kind depends on eternal vigilance.

Of the available data, relating to systematic experimental work with small sewage disposal plants, that conducted at the Iowa State College by A. Marston and C. W. Okey is probably the most comprehensive yet undertaken. The work is being conducted at the Engineering Experiment Station and has covered - at the last report - a period of five years. In all, five plants have been used, of various forms of construction, involving the septic tank operated with and without the dosage siphon and various forms of filters.

Among the conclusions drawn from this work the following seem most nearly to suit the purpose in hand:

"The septic tank should be constructed so as most completely to destroy the currents produced by the entering sewage

which stirs up the contents of the tank and disturbs the purifying agencies".

"It is necessary to use some device for taking away the outflow without creating currents such as will carry away sediment which will clog the filter".

"Mechanical apparatus such as siphons &c. are not permissible in small plants because they are apt to be out of working order".

"Small plants fail to give satisfaction because of lack of attention".

"The effluent from small plant is not of so high degree of purity as that obtained from city intermittent sand filters, but ~~that~~ the effluent should be sufficiently pure to prevent further offensive putrefaction".

As a result of experience with the experimental plants and the conclusions drawn from their operation a plant has been designed that is recommended for use. In Figure 3, and the following description, an attempt has been made to show its construction and the principle of operation. It must not be inferred that this design is recommended as a solution to all the difficulties of small sewage plants. It is given as a suggestion after considerable experience with the small sewage disposal plants in general use and it is hoped that it will overcome at least a part of the shortcomings found in others.

As shown in Figure 5, a plant sufficient in size to accomodate the average country or suburban dwelling is enclosed in a cylindrical space 12 feet in outside diameter and 7 feet 11 inches in depth. It includes a septic tank, a trickling filter

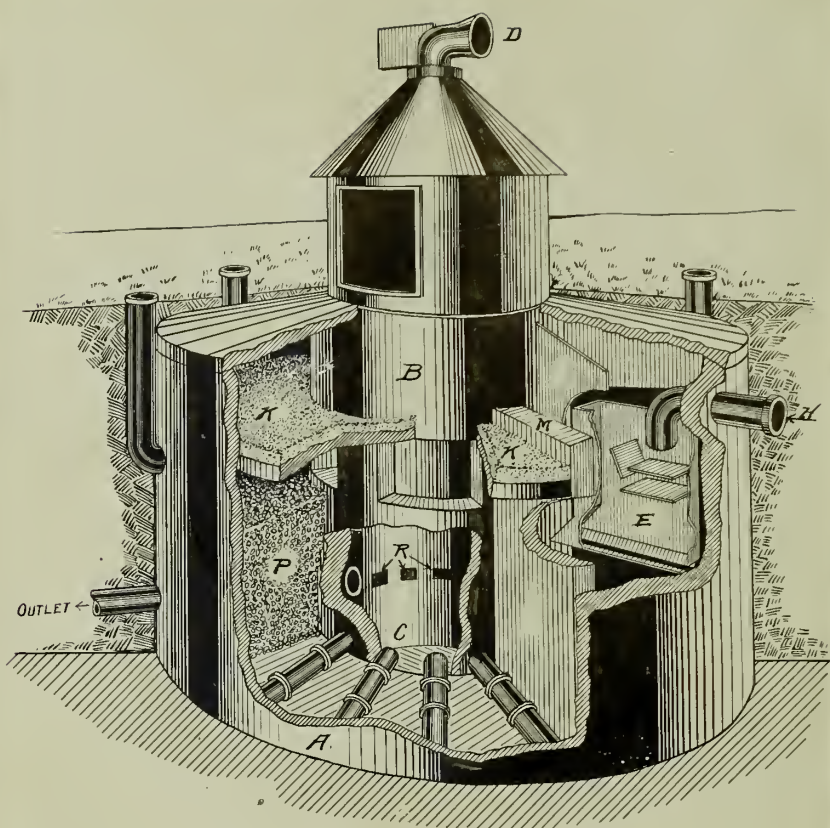


Fig 5

and a filter-bed three feet in depth. The design embodies the features that were suggested by the experimental work.

The plant consists of an outer cylindrical well A, of cemented brick. An inner cylindrical well B, ~~two~~ 4 feet inside diameter and also made of cemented brick, thus forming an inner and an outer well. A sedimentation basin C, at the bottom of the inner well and a ventilator at its top. One-sixth of the outer well is partitioned off to serve as a cesspool or septic tank, as shown at E. This tank is constructed with a system of baffel boards placed to prevent the entering sewage from disturbing the contents. The outer well contains two filters; the upper one K, is made of coarse clean sand and rests on a shelf of reinforced concrete and receives the effluent from the septic tank as it flows into the filter at L. The shelf which supports the upper filter is slotted to allow the water to pass through and fall in drops on the lower filter P, which occupies the lower 3 feet of the outer well. This filter is composed of fine broken stone or pebbles from which all sand has been screened.

Openings in the inner wall permit examination or removal of the filter material. They also furnish means for the free passage of air from the ventilators through the filter.

The sewage enters the septic tank through the pipe H, and after filling this space it finally overflows the wall at G in a broad shallow stream. The effluent flows over the sand-bed K and filters through it to the bed below. After working for some time the effluent will entirely cover the upper filter and stand to a considerable depth above the sand. The sand will finally

become clogged with sewage to such an extent that proper filtration will not take place and it will be necessary to remove part of the roof - which is made in sections - and renew the sand bed.

When working properly the water filters through the sand bed [illegible], and falls into the lower filter [illegible]. After passing through the lower filter, the water enters the pipes S - S at the bottom and is conducted to the basin C, which is lower than the bottom of the filter bed [illegible], and forms a basin in which the sediment will settle.

The openings [illegible], connecting with the ends of the collecting pipes at the bottom of the filter and permits the air to come in contact with the bottom of the bed. The outlet conducts the water to a stream for final disposal.

The cost of materials for the construction of this plant is estimated by the designers to be about $75.00, and the complete cost of construction in a large is placed at $1[illegible].00. The details of construction are given in Figure 5, which shows the plan and sectional elevation of the plant and also the details of construction. Additional details of construction are given of the forms for the roof slabs and also those for the upper filter floor.

Much that has been written on this subject conveys the impression that the septic tank alone used under various conditions will eliminate disease germs and all offending features from sewage and render it a sparkling pure water with a small amount of residue remaining in the tank. That such is not the case is all too evident; many who have constructed plants expecting perfect results have attained only partial success.

It is not reasonable that a plant giving satisfaction under the usual conditions could accomplish its purpose under stress of work. It is quite [illegible] that the amount of sewage from any source cannot be constant. It is equally evident that the effluent from the plant cannot always be the same, but with reasonable limits of variation, a suitably designed tank ought to take care of the sewage from a house at all times and discharge an effluent that is reasonably clear and without offending odor.

It should be kept in mind that as commonly used the chief office of the septic tank is to do away with the things that offend the senses and not to make the effluent that it may serve as drinking water. It must also be kept in mind that if disease germs enter the plant because of sickness in the house, that there is every probability that the germs will be in the discharged water.

The plant must be located as is directed by the natural surroundings but the drainage must be away from buildings and particularly from wells.

Small sewage disposal plants are reasonably efficient and add immensely to the comfort and healthful conditions of the house. They are not perfect in their action but there is excellent reason to believe that the plant of ideal construction will yet be attained.

~~An exxxxxr xxxxxx~~
In a flat country where drainage is difficult, the form of plant must be modified to suit the prevailing conditions but some form of working plant may always be devised. Small plants do not give as efficient results as those of large

since little if any of very complicated work. To do good service they must receive attention but the actual amount of labor that is demanded is small. Small sewage disposal plants are not expensive nor difficult to construct, and for the amount of labor and money expended they give returns that cannot be estimated.

The following extracts taken from the report of the Ohio State Board of Health will give some idea of the working of septic tanks in practice:

"The removal and disposal of well digested sludge from a septic tank is not an objectionable undertaking and does not possess so many disagreeable features as might be supposed. Sludge removal may be carried on without unusual difficulties and with practically no attending xxxxx odor."

"At Shelbyville, O. where the septic tanks or sludge pits (as locally called) are cleaned every six months, a device is used for cleaning that appears to be very satisfactory for small plants. It comprises a bucket conveyor which is placed over the tank on a platform erected for the purpose and by which the sludge is removed by hand and discharged into a tank wagon. From the tank wagon it is discharged by gravity in thin layers on grassed land".

"Present knowledge of Septic Tanks, ... has shown that the tanks exert but little influence upon the character of the liquid portion of the sewage, provided the period of flow is not too prolonged, and that the real function is the removal of the suspended matter and the partial Hydrolysis of the sludge."

"The quantity of the sludge to be removed cannot be accurately stated, since there are many factors with relation

to this operation showed the actual volume of sludge accumulated. .... at [illegible] the Septic Tanks were not cleaned until after five years had passed and then not because ~~xx~~ the accumulations warranted such a step but because of the stoppage of the outlet pipe".

LIMIT OF EFFICIENCY.

In determining the character of plant to be constructed in any particular place, local conditions will in a great measure decide the type to be used. The degree of purity to which it will be necessary to reduce the effluent will depend on the location of the plant and the means of final disposal. If the effluent can be run into a stream of sufficient volume, the septic tank alone will probably answer the purpose.

The septic tank reduces sewage to a liquid form which has some odor. It may be carried away in an open ditch which has good flow but if allowed to collect in pools, it will undergo further putrescence and be objectionable.

It may be possible to reach a small creek for final disposal but one in which the effluent from a septic tank alone, would be objectionable. In such a case the use of the septic tank combined with an anaerobic filter would probably give a permissible degree of purity.

With a plant composed of a septic tank and anaerobic filter, sewage is rendered ~~almost~~ practically free from odor and the effluent will not undergo further putrescence when collected in pools.

In many cases it is desired to purify the effluent still further, either because of lack of means for final disposal or

[illegible]ecause the effluent [illegible] t [illegible] i to [illegible] ich it is discharged. In such cases the plant will consist of the septic tank, [illegible] is filter [illegible] filter ditch or sand-bed filter. The effluent from such a plant will be clear sparkling water that [illegible] i [illegible] for spring water.

LIGHTING AND HEATING WITH GASOLENE.

With the tremendous growth of modern cities, the building of small towns and the improvement in suburban and rural homes, the demand for efficient means of illumination has stimulated an enormous growth in the manufacture of small lighting plants. The development and improvement in electric lighting, has induced an equal if not greater improvement in gas lighting. Up to the year 187[illegible], the open flame gas jet represented the most improved form of city lighting. Then came electricity, which for a time bade fair to supplant all other forms of illumination; but the high cost of electric lighting, even with the advantages it afforded was a stimulus to improvement in less expensive forms of illuminants.

The invention of the incandescent-mantle gas-burner enormously increased the opportunities for gas lighting and opened an inviting field of endeavor. In a relatively short time three distinct types of gasolene lighting plants came into common use with a great number of different systems in each type. The only rival of any consequence to the small gasolene-gas plant of today is acetylene. The dangers attending the use of these agents of illumination have been rapidly illiminated, until today—when intelligently managed—they are fully as safe as any means of artificial lighting. Gasolene plants are now in common use in cities where competition with all other forms of illumination require excellence in service to hold an established place.

In order that any mechanical appliance may be used with the best results, the mechanism must be thoroughly understood and in the case of gasolene plants, not only familiarity with

the mechanism should be acquired but some knowledge of gasolene and its characteristic properties should be gained that the peculiarities of the plant may be more fully comprehended.

GASOLENE is the first distillate of crude petroleum, that is, in the process of separation, the crude petroleum is distilled from a retort and the condensed vapors, at different degrees of temperature, form the various grades of gasolene, kerosene, lubricating oil, paraffin &c. The crude oil is placed in the still and heated. The distillate that first comes from the condenser at the lowest temperature of the still, is gasolene of a light spiritous nature. As the process of distillation continues, this part of the petroleum is entirely driven off and it is necessary to increase the temperature of the retort in order to vaporize more of the petroleum. There is no distinct line of separation between the gasolene that first comes from the condenser and that which comes over after the temperature is raised, except that it is less of a spiritous nature and contains more oily matter. As the temperature of the retort is gradually raised, the distillate contains less and less of the spiritous and constantly more oil.

In order to grade gasolene for the market the standard adopted was that of relative density. For this the Beaume Hydrometer was taken as a standard and all such materials are so graded. The Beaume hydrometer is a scale of relative specific gravities in which the different densities are expressed in degrees. The highest grade of gasolene produced by the first distillation is 90 Beauma; that is, the hydrometer will sink in the gasolene to 90 on the scale. As the temperature of the retort is gradually raised

the distillate will ~~gradually~~ become heavier and the next commercial grade is 86 gasolene. The 86 gasolene contains a greater proportion of oily matter and a less amount of that of a spiritous nature. The next commercial grade that is produced as the temperature is raised is 76 gasolene, a still highly volatile spirit but containing more oil than the last. This process is kept up until there is an amount of oil in the distillate that can no longer be termed gasolene, when kerosene is distilled from the retort.

The following is taken from the laws of North Dakota for the year 1909, under Inspection of Oil and Gasolene:-"All gasolene offered for sale within the state shall be tested for gravity. All gasolene which tests 63 degrees (Beaume) or higher, shall be branded, "approved for sale" and any gasolene which shall test below 63 degrees (Beaume) shall be branded, "rejected for sale"; provided that gasolene produced from petroleum of low grade shall be labeled and sold as low grade gasolene and such gasolene shall have a gravity test of 63 degrees (Beaume) or higher; ...."

The gasolene such as is described in the law does very well for ordinary gasolene stoves and those processes where heat is used to generate the gasolene vapor but it would not do for a Cold Process gas machine because it is not sufficiently volatile at the temperature under which the machine must work. To prove satisfactory the Cold Process machine should be supplied with 86 to 87 test gasolene and preferably the latter. Since gasolene of this grade is not sold for ordinary use, it is necessary in ordering to specify both the grade and for what purpose it is desired.

LIGHTING AND HEATING WITH GASOLENE.

The extended use of gasolene as a lighting and heating agent has brought about the development of a great number of mechanical devices that are intended to furnish the house with an efficient source of illumination and at the same time to provide the kitchen with a convenient and relatively inexpensive fuel. These machines are generally simple in mechanical construction and so designed as to elliminate most of the dangers involved in the use of gasolene. In operation they require a minimum amount of attention when suited to the purpose for which they are intended. That the object of the plants is attained, is attested by the great number in use and the degree of satisfaction afforded the users.

The widespread demand for plants of this character has lead to the development of three distinct systems of apparatus:

1st. the COLD-PROCESS system in which the gasolene is vaporized at the temperature of the underground supply tank and after being mixed with the required amount of air is sent through the building in ordinary gas pipes exactly as in the case of city gas.

2nd. the HOLLOW-WIRE system in which the gasolene is sent to the burners in liquid form, from a supply tank, where it is vaporized in the burners by heat and there mixed with the necessary air to afford complete combustion.

3rd. the CENTRAL GENERATOR or TUBE system, in which the gasolene is sent to a central generator from a supply tank and there vaporized by heat and at the same time mixed with air in sufficient amount to render it a completely combustable gas with-

out further dilution.

THE COLD-PROCESS GAS MACHINE.

The gas machine of the Cold Process type is so arranged that the air is forced through a tank or carburetter, containing gasolene and remains in its presence until saturated with gasolene vapor. This saturated air is afterward diluted with additional air to produce a quality of gas that contains proportions of air and gasolene vapor, such as will produce complete combustion when burned with an open flame. Combustion is a rapid chemical change in which heat is envolved, due to the union of carbon and oxygen. If the carbon is completely oxydized , the combination produces (CO_2) carbon dioxide and the greatest amount of heat is produced.

Gasolene being a highly volatile liquid, it will vaporize at temperatures as low as -1 degrees F. but as the temperature is higher, vaporization will be more rapid. In a confined space at relatively low temperature such as the carburetter of a gas machine the vaporization will at first be very rapid but after the more highly spiritous portion has been evaporated a considerable part, even of the lighter grades will be vaporized very slowly. In the cold process machines only the lighter grades can be used with success and even then, in inefficient machines a portion of the lesser volatile gasolene will have to be thrown away. For this reason and for others that will appear later it is advisable to consider very closely the working properties of the entire plant.

In order to obtain gas that will always be of the same

quality and at the same time use gasolene in an efficient manner, the gas machine must be composed of three essential parts; the Blower, the Carburetter and the Mixer.

The BLOWER is that part of the machine which supplies the air for absorbing the gasolene vapor and maintaining a constant pressure on the system. It is usually in the form of a rotary pump, the motive power for which is a heavy weight. The pump may, however, be driven by water pressure furnished by city water pipes, or other water supply.

The CARBURETTER is a tank which contains the supply of gasolene and so constructed as to permit the air from the blower to most readily take up the gasolene vapor. It should be so arranged that when the contained gasolene becomes old and less volatile, the air may remain in its presence a sufficient time to become saturated by slow absorption.

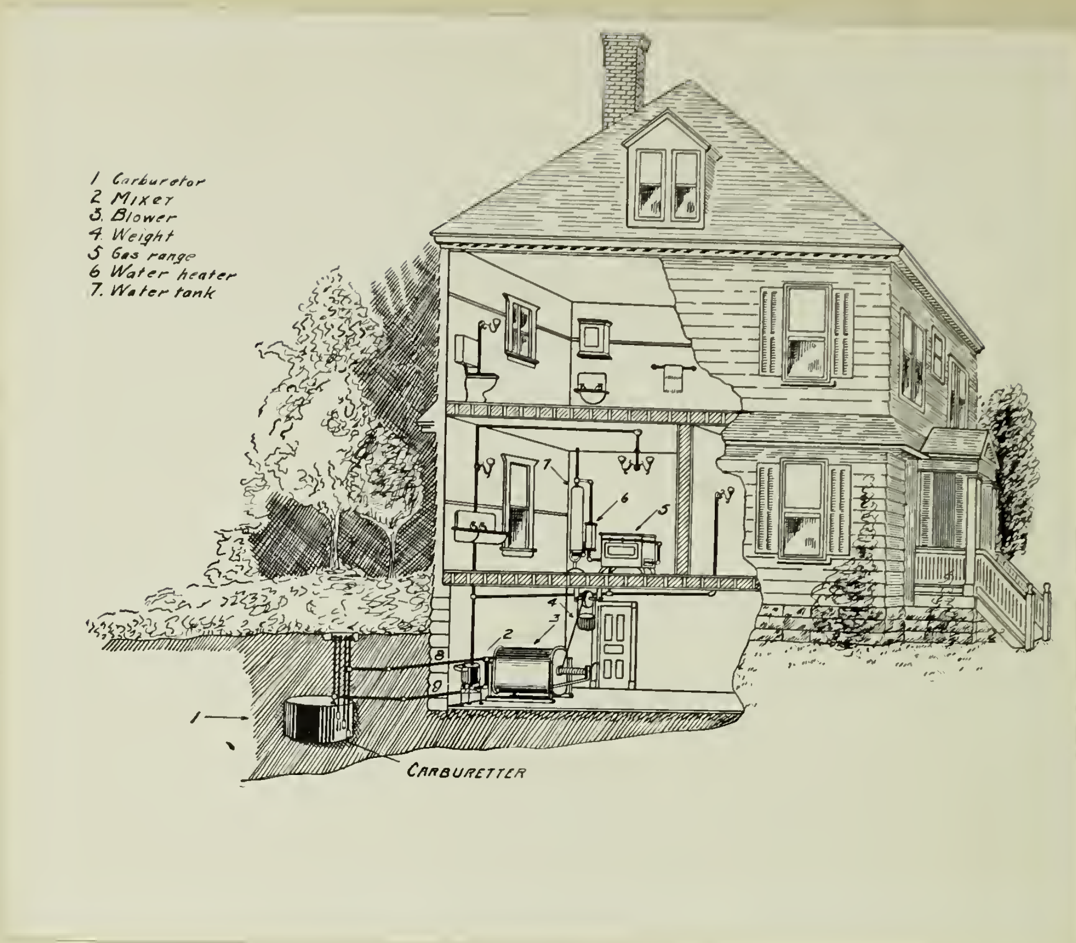
The MIXER is that part of the machine which regulates the amount of gasolene vapor contained in the gas entering its distributing pipes. In order to satisfactorily perform its function it should be so arranged as to permit a constant amount of gasolene vapor to enter the mixture which composes the finished gas. This amount should be such as to produce a bright clear flame in an open gas jet. If the gas contains too great an amount of gasolene vapor the flame will smoke; if too little gasolene vapor is present the flame will be pale and lacking in heat. The gas machine to be satisfactory must produce a quality of gas, that when burned in an open jet will not smoke or give off odors. The flame should be clear and bright. This result should be obtained at all times no matter what may be the surrounding temperature, the amount

of gas being used in the house or the quality of gasolene in the carburetter. It is evident that the faithfulness with which the mixer performs its duty determines the degree of satisfaction with which the machine does its work.

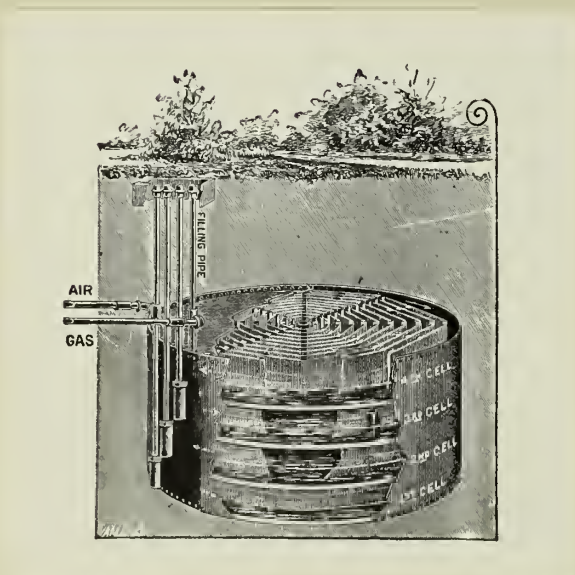
In the figure 123, the entire plant is shown in place, the blower is shown at 3. It occupies a place inside the building, usually in the basement. The motive power of the blower is furnished by a heavy weight 4, which is raised by a block and tackle, the cord of which is attached to the drum and fastened to the shaft of the blower. The force furnished by the weight drives the blower and maintains a constant pressure on the gas in the system. The pipe 8, conducts the air from the blower to the carburetter, which is located underground below the frost line and 25 or 30 feet away from the building.

The carburetter in this case is also the storage tank. As is shown in detail in figure 124, it is divided laterally into two or more compartments, depending on the size of the plant to be accommodated. The compartments are only partly filled with gasolene because the air from the blower passes through each compartment in succession, beginning at the bottom, in order that it may become saturated with gasolene. As an additional means of aiding the saturation of the passing air, the compartments are provided with spiral passages of absorbent material through which the air must pass, so that when it reaches the outlet pipe 9, the air, is completely filled with gasolene vapor.

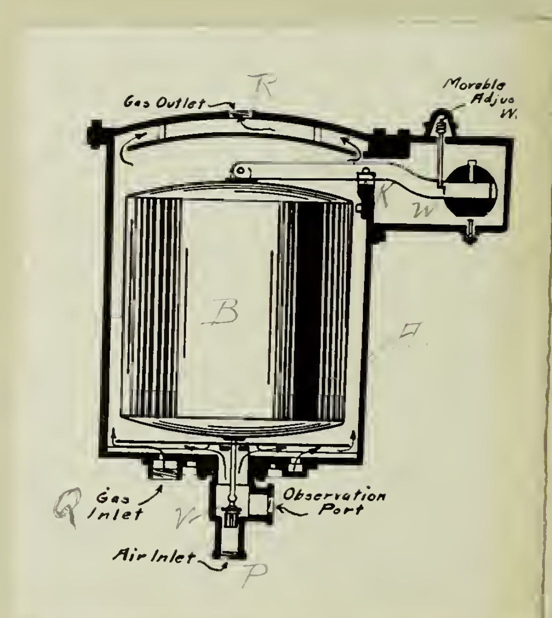
The vapor-saturated air now leaves the carburetter by pipe 9, in figure 123, and enters the mixing chamber 2, where it is mixed with the required amount of atmospheric air to make it completely


1 Carburetor
2 Mixer
3 Blower
4 Weight
5 Gas range
6 Water heater
7 Water tank
CARBURETTER

123


FILLING PIPE
AIR
GAS

124,


Gas Outlet
R
B
W
Gas Inlet
Q
V
Observation Port
Air Inlet
P

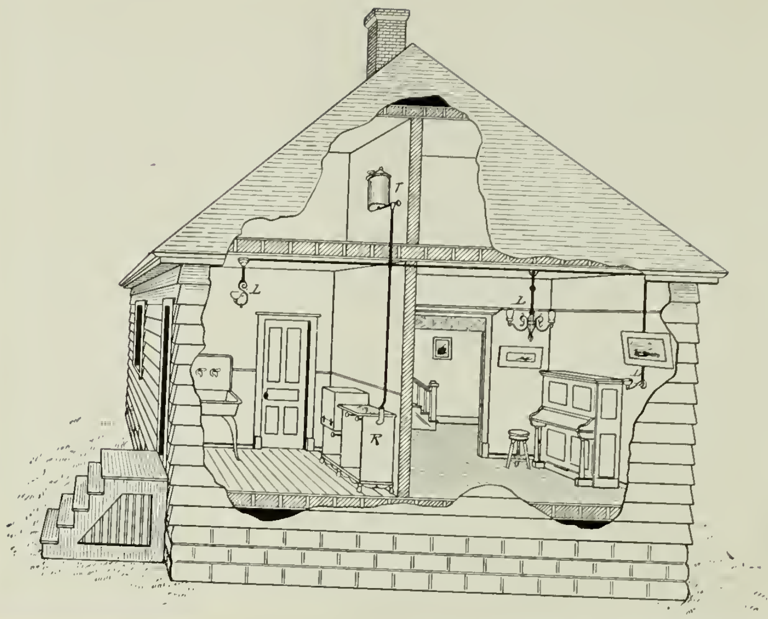
125

combustible when burned at the burner. In Figure 125 the mixing chamber appears at 2, and is shown in detail in Figure 125. The mixing is done automatically and the quality of the gas is made constant, regardless of the varying conditions of the attending temperature and the quality of the gasolene in the carburetter.

The vitally important feature of any machine is that a constant amount of gasolene vapor be carried to the burners. If the gas contains too great amount of gasolene vapor a smokey flame will be the result; if an insufficient amount of gasolene is present the flame will not be bright. When freshly charged, the gasolene in the carburetter will vaporize very readily and a large amount of air must be added to the gas to reduce it to the proper consistency; but from old gasolene which has lost most of the light, volatile matter a smaller proportion of atmospheric air will be demanded. For this reason a mixing regulator that will always deliver gas containing the same amount of gasolene vapor, is necessary to produce satisfactory service. The mixer shown in Figure 125 accomplishes this office by reason of the specific gravity of the gas.

As the air in the carburetter takes up gasolene vapor its specific gravity is increased until the air is saturated and by adding the amount of atmospheric air necessary for complete combustion, the weight is reduced to a definite amount which will be a constant quantity. The required mixture will therefore always weigh the same amount. The principle on which this mixer works is that described in physics as the principle of Archimedes; "that a body immersed in a liquid will lose in weight the amount of liquid displaced.

The mixer shown in figure 2, is cut across lengthwise. The outside casing is shown at A. Openings are shown at G,. to admit gas from the carburetter and at I, to admit air from the blower. The outlet H, connects with the pipes supplying the building with gas. The float F, occupies most of the interior space. It is a light metallic drum that is tightly sealed and nicely counterbalanced by the weight W. The knife edge at K, is very carefully constructed to make a sensitive balance. The valve V, controls the amount of air to be admitted at I. The entering gas from the carburetter being heavier than the desired mixture, will raise the float and in so doing will open the valve V, and allow the air from the blower to enter. The float and valve are so adjusted that the desired mixture is attained when the balance beam is level. Any variation in the mixture will change its weight and the valve to correct the change whether it be too much or too little air.



126

127

THE HOLLOW-WIRE SYSTEM.

OF

GASOLENE LIGHTING AND HEATING.

The Hollow-Wire System of gasolene lighting possesses the advantage of simplicity in construction that makes it attractive, particularly for use in small dwellings. The same principle is also extensively used in portable lamps where a remarkably convenient and brilliant lamp is made to take the place of the customary kerosene lamp. Small portable gasolene lamps are now extensively made that are not only efficient and convenient as a source of light but make a handsome appearance wherever used.

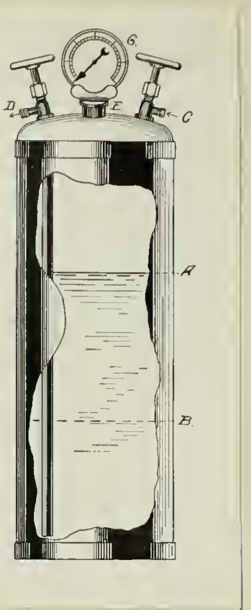
The Hollow-Wire system as commonly employed is illustrated in figure 126, and 127. In the gravity type of the system as illustrated in figure 126, the supply of gasolene is stored in the upper part of the house in a tank T, and conducted to the burners below, through a system of small copper tubes as indicated by the heavy lines in the drawing. The same tank is used to supply the gasolene for the stove S, in the kitchen and the lamps L, in the different apartments. The gasolene supply in this case is obtained entirely by gravity. This plant is not approved by the National Board of Underwriters but its use is quite generally permitted. The storage of gasolene, in this form, should be done with caution as carelessness or accident might lead to serious results. With an arrangement of this kind the force of gravity gives the pressure which supplies the burners below and it would not be possible to use the lamps on the same floor with the tank.

Where it is desired to use lamps on both floors a pressure

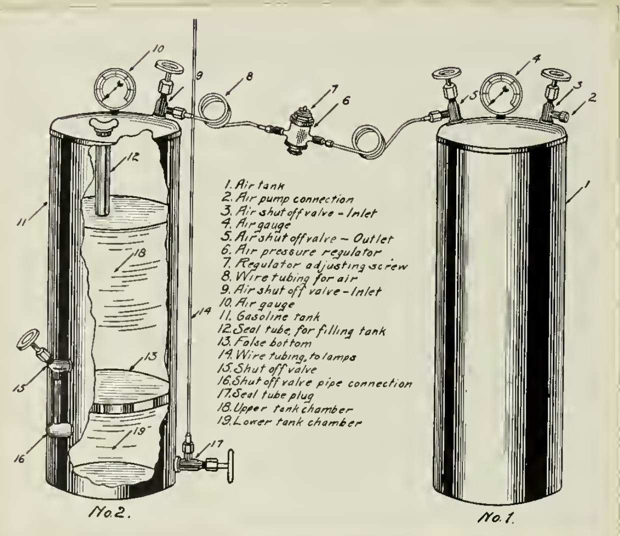
tank is employed for supplying the gasolene to the lamps, as indicated in figure 127. In this plant the pressure tanks, S. T. in the basement furnish the pressure which forces the supply of gasolene through the small tubes to the lamps L. in the different rooms and also to the stove R. in the kitchen.

The means of furnishing the pressure for supplying the gasolene to the burners may be a simple tank as that in figure 128 or the more elaborate apparatus shown in the double tank of figure 129. Either style will give good results, but the double tank requires the least attention in operation and is therefore more satisfactory in use. The tank in figure 128 is made of sheet metal of such weight as will safely withstand the pressure necessary in its use. It is arranged with an opening E, for filling the gasolene, a pressure gauge for indicating the pressure on the gasolene and two needle valves, C, for attaching an air pump and D, to which the hollow-wire is attached for supplying the fixtures with gasolene. The tank is filled with gasolene to about the line A, and then air pressure is applied with the pump to say 20 pounds to the square inch. This pressure will be much more than will be necessary to force the gasolene through the tubes but it is intended to last for a considerable length of time.

The principle of operation is that known in Physics as Boyles Law, "that the temperature being constant, the pressure of a confined gas will be inversely as its volume". That is, if the tank is perfectly tight, the pressure above the line A, in the tank, will gradually become less as the gasolene is used and when its level is at the line B, where the volume is twice the


D
E
C
A
B.

128


1. Air tank
2. Air pump connection
3. Air shut off valve - Inlet
4. Air gauge
5. Air shut off valve - Outlet
6. Air pressure regulator
7. Regulator adjusting screw
8. Wire tubing for air
9. Air shut off valve - Inlet
10. Air gauge
11. Gasoline tank
12. Seal tube, for filling tank
13. False bottom
14. Wire tubing, to lamps
15. Shut off valve
16. Shut off valve pipe connection
17. Seal tube plug
18. Upper tank chamber
19. Lower tank chamber
No. 2.
No. 1.

129.

the original amount, the pressure will be 1/2 what it was originally, and will still be sufficient to force the gasolene through the tubes to the lamps. If at any time the pressure in the tank becomes too low to feed the lamps, a few strokes of the pump will raise it to the required amount. While this tank does the required work, its use is not perfect, because the pressure is constantly varying. If a lamp is set to burn at a definite pressure any decrease in the gasolene supply due to falling pressure, will change the amount of light given by the lamp. While the variation in the pressure of the single tank is not great and gives good results, in practice a more perfect effect is attained in the double type of tank as that of figure 129.

The object attained in the use of two tanks, differs with different manufacturers. The tanks shown in figure 129, being intended to maintain a constant pressure on the gasolene, is quite different from those described in figure __, in use with the Central Generator system of lighting. In figure 129 tank No. 1, is for air supply alone and tank No. 2 is the storage tank for gasolene. Between the two tanks is a pressure regulating 6 - 7 which keeps a constant pressure in tank No. 2, so long as the air pressure of the tank No.1 is equal or greater than the other. The gasolene in tank No. 2 will therefore be always under the same pressure and when the lamps are once burning, the gasolene supply to each lamp will be a constant amount. Tank No. 2, is separated by the head 13, into two compartments, marked 18, and 19, ~~respectively~~. The connection between the two compartments is made by the valve 15, and the connection 16. The gasolene supply for the lighting system is taken from the lower

THE HOLLOW-WIRE SYSTEM.

chamber at the valve marked 17.

It is possible to refill this tank with gasolene while the system is working. To accomplish this, the air supply is cut off from the tank No. 1, by closing valve 9, and the valve 15, is closed to retain the pressure on the lower chamber of tank No. 2. The screw-plug is then taken from the tube 12, and the tank refilled. After returning the screw-lug to its place, the valves 9, and 15, are again opened and the regulating valve immediately restores the desired pressure.

The amount of pressure required on the system will depend on the height to which the gasolene is carried in the building. The pressure is generally one pound to each foot in height and to do the best work the pressure must be constant.

These plants may serve as a fuel supply for a gasolene stove as indicated at R,, or any other source of domestic heating. The usual gravity supply tank of the stove is replaced by the hollow-wire which is a part of the system and the figure branches form the main wire at the point marked B..

MANTLE GAS-LAMPS.

Mantle lamps that are intended to use city gas are much the same in construction as those using the Cold-Process gasolene gas, the styles of mechanism differ somewhat with the manufactureres but all lamps of this kind possess the same essential features that are common to all. Either of these gases may be used with open flame burners, such as figures 130 but since the introduction of mantle lamps, the open flame burners are

rarely used for household illumination.

In the incandescent-mantle lamp, the light is produced by heating to incandescence a filmy mantle of highly refractory material. The higher the temperature to which the mantle is raised, the greater the quantity of light is produced. The office of the burner is to produce a uniform heat throughout the mantle with the use of the least amount of gas. As ordinarily furnished from the mains, coal gas or gasolene gas is too rich in carbon to be used in the mantle without dilution. Without being diluted with air these gases will not undergo complete combustion and as a result will smoke the mantle and give an unsatisfactory light.

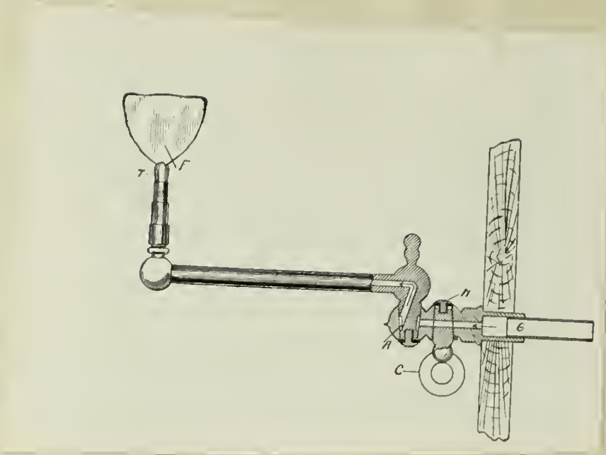
HEATING AND LIGHTING WITH GASOLENE.

In the use of the various gases from coal, gasolene, kerosene, alcohol &c. as a fuel for the production of either heat or light, the form of the burner in which the gas is consumed, is the most important factor of the system. Without burners in which to generate a satisfactory supply of heat for the desired purposes gas plants would never have come into common use. An understanding of the mechanism of the burners of a system is of first importance because of the possibility of the failure of the entire plant through an improper adjustment of the lamps.

If complete combustion of the gas is attained in the burner, the greatest amount of heat will be evolved from the burning fuel and the residue will be an odorless gas, carbon dioxide ($C O_2$). If the gas is not completely burned the odor of gasolene is noticable in the air. Incomplete combustion may be caused by an insufficient air supply which will produce a smokey flame, or if a larger flame is used than the burner is designed to carry, some of the gas will escape unburned. In either case the greatest amount of heat is not developed by the burner.

In most burners, whether for heating or lighting — in which gas, gasolene or alcohol is used as a fuel — the principle of operation is that of the Bunsen tube. One noticable exception to this rule is the burners used with the Central generating systems; where the Bunsen tube is a part of the generator.

The gas as generated from any hydro-carbon will not burn completely without being mixed with air or other incombustable gas in proportions such that when burning, the surrounding air will completely oxidize the carbon contained in the fuel.



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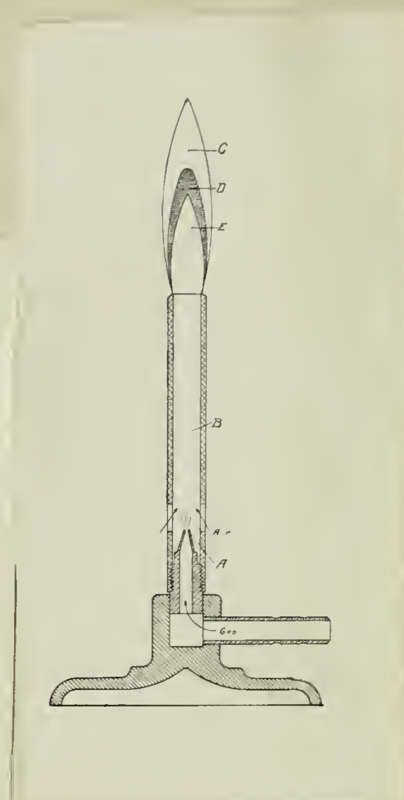

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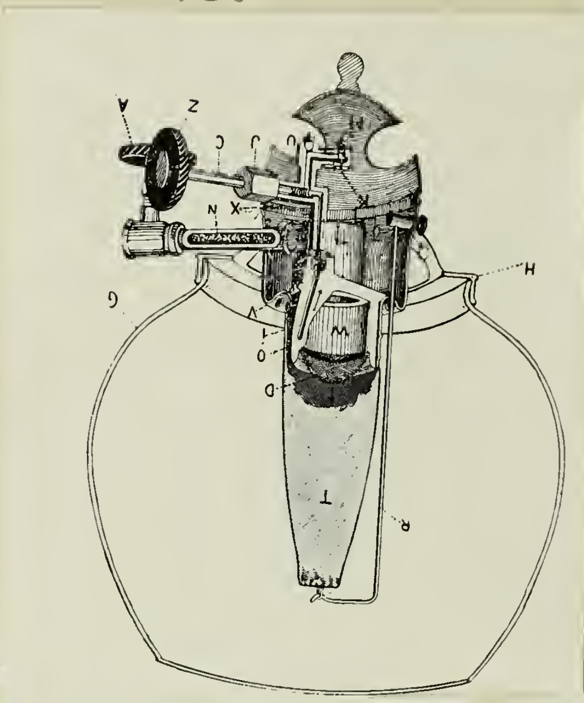
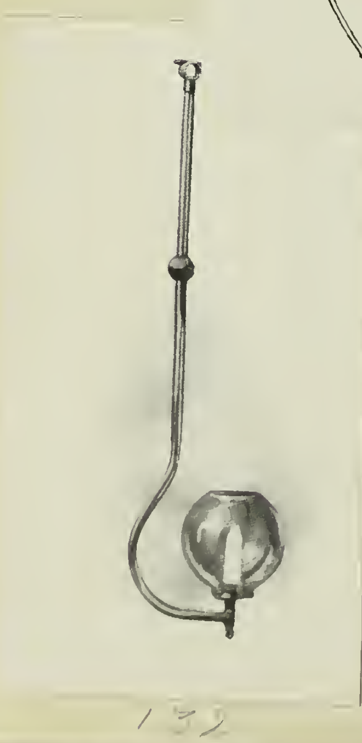


130-a



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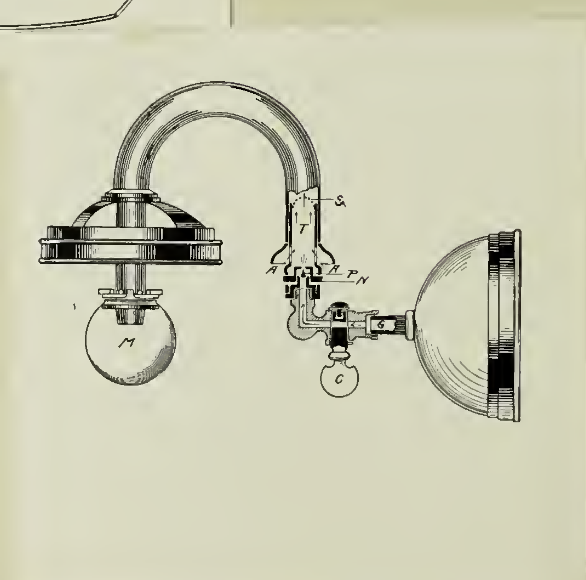


133

GASOLINE LIGHTING AND HEATING.

In figure 131 the familiar laboratory Bunsen burner affords an excellent illustration of the Bunsen principle. The gas from the supply pipe issues from a small opening A, into a tube B, and by the force of its velocity the entering gas carries into the tube above it, a quantity of air that may be regulated by the size of the opening. If the gas is burned without being first mixed with air, the flame will be dull and smokey, but if air is admitted to mix with the gas, an entirely different flame is produced, the characteristic shape of which is shown in the figure. The upper part of the flame C, is known as the reducing flame. It is blue in color and intensely hot. The portion D, is the oxidizing flame and pale blue, sometimes light green in color. The lower part E, is the gas before it begins to burn. When burning in air the Bunsen flame gives scarsely any light, all of the energy being expended in heat. In the gas stove where the burners are made up of a great number of small jets, it will be seen that each jet shows the characteristic features of the Bunsen flame.

The incandescent-mantle gas-light takes advantage of the heat generated by the Bunsen flame and produces an incandescent light that has revolutionized gas lighting. The flame of the Bunsen tube is burned inside a mantle which is rendered incandescent by the heat.

The incandescent mantle was invented by Dr. Auer von Welsbach and was known for a long time as the Welsbach light, but improvements in the process of making the mantles brought other lamps of the same type on the market when it became

known as the mantle lamp. The first servicable mantles were made in 1891 and from that time there has been a steady developement in gas lighting industry.

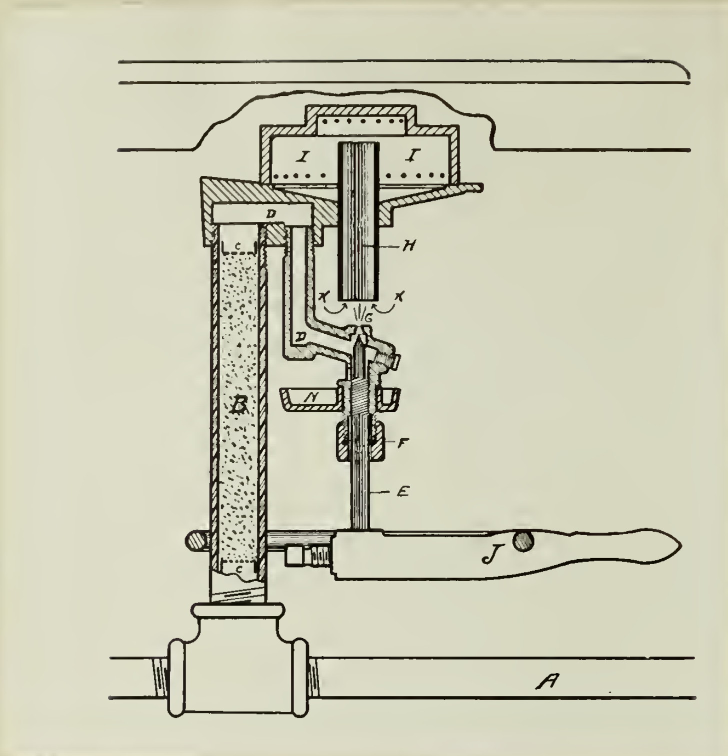
The original mantles were made of knitted cotton yarn impregnated with rare earth, and are still so made, but the most durable mantles are now constructed from ramie or china grass. After being knitted the mantles are impregnated with thorium nitrate with the addition of a small quantity of cerium nitrate and occasionally other nitrates. The mantles are then shaped and mounted, the fiber is burned out and the mantle is dipped in collodion to give them stability for transportation. When placed in the lamp for use the collodion is first burned and the remaining oxide of thorium forms the incandescent mantle. One style of mantle is now being made in which the fiber is not burned out until it is placed in the lamp. They are commonly used with gasolene lamps and give very good results.

The first incandescent-mantle gas lamps to be used were of the upright type such as is shown in figure 132 and for a long time they were the only mantle lamps in use. While the upright mantle was a great improvement over the open flame gas-jet, the lamp was not satisfactory because of the shadows cast by the fixture and from the fact that a large amount of the light was lost by being directed upward from the source of illumination.

With the developement of the inverted type, the mantle lamp was greatly improved. From the position in which lamps of any kind are ordinarily used, the desired position of the illuminant is that where the light is directed downward. In the

present inverted type of mantle lamp this feature adds materially to the efficiency of the light, because the rays are sent in the direction of greatest service. The upright mantle lamps are still sold but by far the greater number offered for sale is of the inverted type. The essential features of all gas lamps used under these conditions are shown in figure 133, which represents the common bracket type of lamp. The gas-cock C, connects the lamp with the gas supply G. The gas escapes into the Bunsen tube through an opening in the tip P, which is so constructed that the amount of gas may be varied to suit the required conditions. The brass screw nut N, may be raised or lowered and thus increase or diminish the amount of escaping gas by reason of the position of the pin P. If the nut is screwed completely down the pin closes the opening and the gas is entirely shut off. When the lamp is put in place the burner is adjusted to admit the proper amount of gas and so long as the quality of gas remains the same, no further adjustment will be necessary. Any change to a richer or poorer gas will however, require an adjustment of the burner to suit the mantle.

As the gas leaves the opening above the pin P,, it enters the Bunsen tube, where air is drawn at the openings A,-A, and the mixture passes over to the mantle M, where it is burned. In all lamps of this kind there is a screen placed relatively as S, the object of which is to produce a uniform mixture of the gas. It also prevents the mixture of gas and air from exploding in the tube-in case of low pressure- and thus cause the gas to ignite and burn in the mixing chamber. Lamps of this kind are



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very generally covered with an opal glass globe in order to diffuse the intense light which comes from the mantle.

BURNERS FOR GASOLENE STOVES, are made in a great variety of forms each having some special points of excellence that are used to recommend the sale of the stove. The most essential feature of a gasolene stove is the burner, since on its successful performance will depend the satisfaction given by the stove. Many self generating burners have been devised which have met with a great deal of favor but the type of burner most widely used and the first to be devised for the purpose is the generating burner similar in principle to the generating gasolene lamp.

The generating portion of the burner is first heated from an outside source, in order to generate sufficient gas to start the flame, after which the heat from the burner will develop its own gas supply.

In portable gasolene stoves the supply-tank is elevated in order that the force of gravity may give sufficient pressure to send the gasolene into the generator while the flame is burning. In the hollow-wire system the same type of burner is used but the gasolene is forced into the burner by the pressure in the tank.

In figure 134 is shown a sectional view of the burner as it appears in the stove. The supply or hollow-wire from the pressure tank sends the gasolene into the tube A, at the bottom of the stove; to which several burners may be attached. The tube B, through which the gasolene percolates, on its way to the generator is filled with moderately coarse sand or other

material that is intended to prevent the gasolene from being forced out of the pipe by the pressure that is developed in the generator. The pieces C,-C, are perforated metal plugs that prevent the escape of the particles of which B, is composed.

The generator is a brass casting D,-D, which is firmly screwed to the top of the piece F. A needle-valve E, governs the discharge of the gasolene vapor at C, where the vapor enters the tube H, as indicated at K,-K. As the vapor enters the tube H. there is carrying with it the amount of air necessary to produce the required gas for complete combustion. The piece N, is the generating cup in which is burned the generating fluid, either gasolene or alcohol.

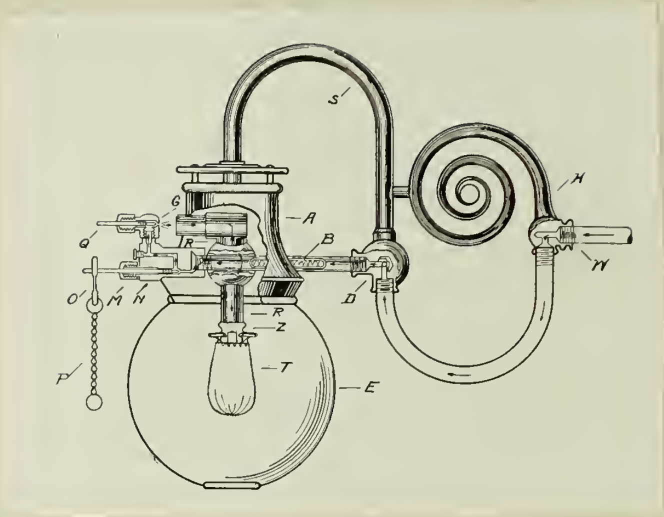
To light the burner the hand-wheel J, is turned, opening the needle-valve to allow the gasolene to escape and fill the cup. A still better way is to fill the cup with alcohol because the burning alcohol does not fill the air with smoke and odors as in the case of gasolene when used for generating purposes. When the generating material has burned out, the generator is hot and filled with vapor, so that the needle-valve may be opendd and the gas lighted above the burner I,-I, where it should burn in little jets at each opening with the characteristic Bunsen flame. It some times happens that the generator is not heated sufficiently ~~the~~ by the generating flames to vaporize the necessary gasolene for starting the burner. In this case liquid gasolene will be forced from the opening G. and the burner will flare up intermittently in a red smokey flame. When this occurs the burners must be regenerated.

HOLLOW-WIRE SYSTEM.

OPEN-FLAME GAS BURNERS:- Gas jets of the open-flame type are still used to some extent but the more efficient mantle lamp has very largely supplanted lights of this kind. In the past these gas lights were made in a great many types and were known under a variety of trade names- the fish-tail burner, the bats-wing burner and the Argand burner, were at times very generally used for gas lighting.

The common gas jet of today is illustrated in figure 130, This is bracket type of fixture which is generally fastened to a pipe in the wall. A swing-joint at A, permits the flame F, to be moved into different positions. The annular opening A, permits the gas to pass to the jet in any position to which the light is moved. The gas-cock C, is a cone-shaped plug which has been ground to perfectly fit its socket. It should move with perfect freedom and yet prevent the escape of the gas. A slotted screw N, permits the joint to be readjusted should the plug become loose in the socket.

The gas-tip T, are made of a number of different kinds of materials and are commonly termed lava-tips but tips for gas and gasolene are frequently made of metal. The bottom of the tip is cone-shaped which permits it to be forced into place in the end of the tube with a pair of pliers. In size the tips are graded in cubic feet per hour. For example-a four-foot tip will use approximately four cubic feet of gas per hour. They are made in a number of sizes to suit the varying requirements.



135

THE HOLLOW-WIRE SYSTEM.

THE INVERTED-MANTLE GASOLENE-LAMP.

The inverted-mantle gasolene-gas lamp shown in figure 135, furnishes a good example of mechanism and principle of operation used with the hollow-wire system. This is the bracket style of lamp but the same mechanism is used in other forms of fixtures. Lamps of similar construction are suspended from the ceiling either singly or in clusters and are also used in portable form.

In figure 135, the lamp consists of a bracket N, which is secured to the wall and through which the gasolene is brought to the generator by the pipe W. The arrows show the course of the gasolene as it passes through the lamp. The asbestus plug P, is a part of the generating chamber and prevents the vapor pressure from acting directly on the gasolene, in the supply tube. The gasolene passes through the plug P, largely by capillary action, as it must enter the generator against a pressure greater than that afforded by the pressure tank. The vaporization of the gasolene takes place in the tube directly above the mantle, from which it receives its supply of heat.

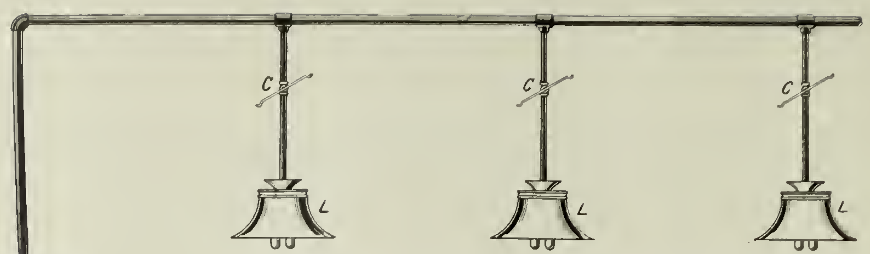
In lighting the lamp an asbestus torch saturated with alcohol is ignited and hung on the frame, so that the flame may heat the generator casting N. This process usually requires less than a minute, generally about 40 to 50 seconds. The torch supplies heat sufficient to generate the vapor for lighting the lamp but as soon as lighted the heat from the glowing mantle keeps the generator at the required temperature for continuous supply of vapor.

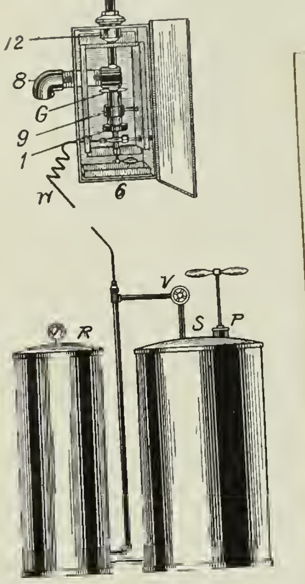
When the generator is sufficiently heated by the generating

torch the needle valve N, is opened by pulling the chain P. This allows the gasolene vapor from the generating tube to escape at G, into the induction tube R. As the vapor enters the induction tube at a high velocity it carries with it the atmospheric air in quantity, depending on the size of the tube and the distance of the opening form G. The lamp is so proportioned as to give a mixture of gasolene vapor and air that will produce complete combustion in the mantle T. The portion of the burner Z, through which the gas enters the mantle, is a brass tip filled with a fluted strip of German-silver, so arranged that the gas on entering the mantle will be uniformily destributed and that the heat generated will render the entire mantle uniformily brilliant.

One feature of the lamp that requires special attention is the opening G, through which the vapor from the generator discharges into the induction tube. This is a very small opening and occasionally becomes stopped or partly closed. When this occurs the lamp fails to receive the necessary amount of gas and the light is unsatisfactory. In this lamp the cleaning needle Q, is provided for removing the stoppage. The needle is simply screwed into the opening and forces out the obstruction, when it is withdrawn the opening is left free. A more convenient device for accomplishing the same purpose is described in the protable lamp, figures 139, 140.

The tip G, and the induction tube R, are necessary to all lamps of this type. This combination forms the Bunson tube that is necessary to produce the mixture of air and gasolene required for complete combustion. The Busen Gas-burner so common in scientific laboratories furnished the principle on which all such are operated.





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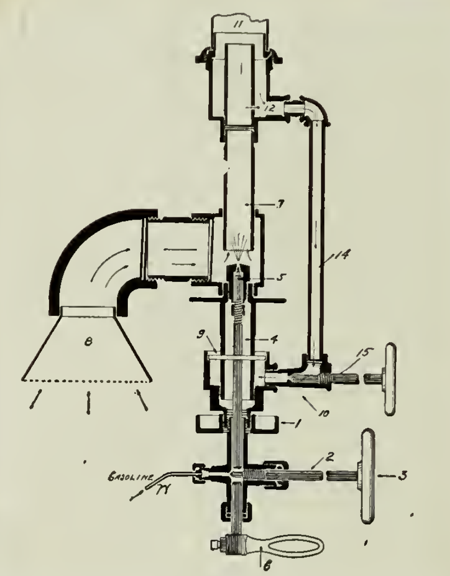

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CENTRAL GENERATOR PLANTS.

The Central Generator or Tube System of lighting with gasolene differs from the other methods described in the manner of generating and distributing the supply of gas to the lamps. In the Hollow-Wire system each lamp generates and mixes its own gas supply. With the Central Generator system the gas for all of the lamps is generated and properly mixed with air in a central generator and distributed through tubes, to the different burners and there burned under incandescent mantles, but the gas requires no further mixing with air and therefore the burners are not of the Bunsen type.

Central Generator Gas-Machines are made in a number of different forms by different manufactures all of which are intended to perform the same work but differ in the mechanism employed. The machines are simpler in construction than the Cold-Process plants, much less expensive to instal and are capable of using the lower grades of gasolene that could not be used except with a hot generator. The gas may be used for all purposes for which gaseous fuel is employed either for lighting or heating. One difficulty in the use of the machines is the lack of flexibility when required for a small and varying number of lights. Although they are often used for lighting and heating dwellings, their use is limited, for the reason that variation of the number of lights require the generator to be regulated to suit the change. The plants cannot be conveniently cut down to one light. Their most general use is that of lighting churches, stores, halls, auditoriums etc., where a variable amount of light is not demanded. Plants of this character are quite generally used for street lighting and for other purposes requiring outside illumination.

CENTRAL GENERATOR PLANTS.

An efficient and simple plant of the Central Generator type is shown in figure 136. The supply of gasolene is stored in a tank similar to that used with the Hollow-Wire system and which in plants of considerable size are located outside the building. The gasolene in this plant is conducted to the generator G, through a hollow-wire W. The generator is inclosed in a sheet iron box which is located at any convenient place in the building. From the generator the gas is conducted through the tube T. to the lamps, L.

In figure 137 is shown a diagram of the generator cut through the middle lengthwise, in which all of the working parts are shown in their relative positions. The reference figures designate the same parts of the generator in figures 136 and 137.

In the process of generation the tank is filled with gasolene and pressure applied with the air-pump. The tanks described in figure 129, might be used to advantage with this plant but the one used in this case is so constructed that the larger tank is used for storage of gasolene and pumped directly into the smaller tank which alone is kept under pressure. The pump P, is inclosed in the large tank. At any time it is desired to replenish the supply of gasolene it is only necessary to open the valve V and pump the necessary supply into the small tank. This transfer may be done at any time without danger from escaping gasolene vapor.

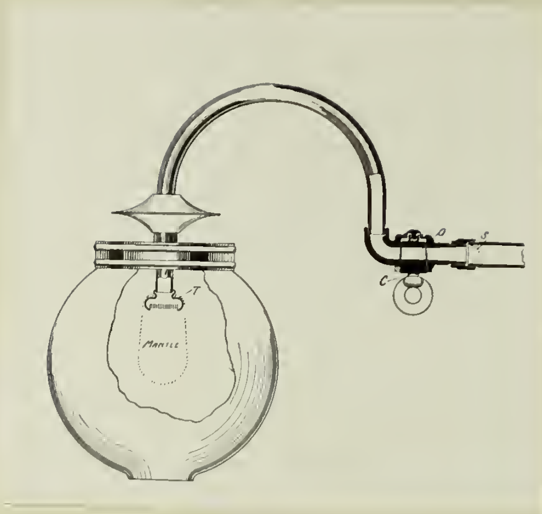
To start the generator the cup 1, is filled with alcohol and ignited. The needle valve 2, is now opened, by turning the hand-wheel 3, admitting gasolene into the generating chamber 4, where the vaporization of the gasolene takes place. The flame from the burning alcohol will heat the generator

in about a minute. When the generator is hot the needle valve 5, is opened slightly by turning the liver 6, and the gasolene vapor under high pressure blows into the tube 7, where it is mixed with air that is drawn in through the opening 8, by the entering blast of gasolene vapor, as indicated by the arrows.

The sub-flame located at 9, is for keeping the generator hot. It receives its supply of gas at 12, which is conducted to the sub-flame burner through the pipe 14, as indicated by the arrows. The size of the sub-flame is regulated by the valve 1[illegible]. The valve 10, regulates the amount of gas that is consumed in the sub-flame and so regulates the amount of heat necessary to produce the required amount of gas. The needle valve 5, is adjusted by the lever 6, to the amount of gas required for any number of lights.

Gas machines operated on this principle are made to accommodate a definate number of lamps. After the lamps are lighted, the amount of gas is regulated to suit the number in use. If at any time it is desired to reduce the number of lamps being used, the machine must be regulated to suit the lights left burning. As an illustration suppose that a plant of ten lamps had been burning and that it was desired to reduce the number to six. The lamps to be extinquished by turning the lever 3, which control the gas-cocks. The generator which had been supplying sufficient gas for ten lights will continue to produce the same amount until the lever 6, is turned to reduce the supply of gasolene to the required amount for six lamps.

In small plants the least number of lamps that will work



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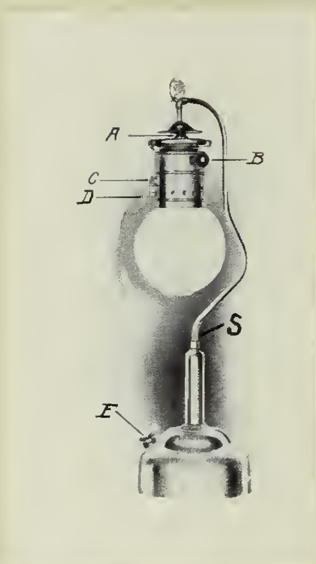

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satisfactorily at one time is three. Automatic regulators are made for plants of considerable size but they do not satisfactorily control the gas when the lamps are reduced below that number. - The gas from these plants may readily be used in kitchen ranges, water heaters and other domestic purposes. Individual plants for operating ranges in restaurants and hotels are in common use. The plants are subject to minor derangements that require correcting as they occur but as soon as the mechanism and characteristic properties of the plant are known, the correction of any difficulty that may present itself is easily accomplished.

Central Generator Gas Lamps:- Figure 138 shows in general construction and arrangement of the parts, of the inverted mantle lamp used with the Central Generator system.

In outward appearance the lamp is much like any gas lamp useing the inverted mantle but in arrangement of the different parts it is markedly different. The gas-cock C, is larger than that used with the ordinary fixture, because the opening 6, must carry a larger volume of gas than that for supplying gas to lamps using the Bunsen tube. In the Bunser tube, the gas from the mains is mixed with approximately twenty times its volume of air, so that with a lamp like that of figure 138, where the mixture has already been made in the generator, the conducting tubes and the gas-cock must be relatively very large.

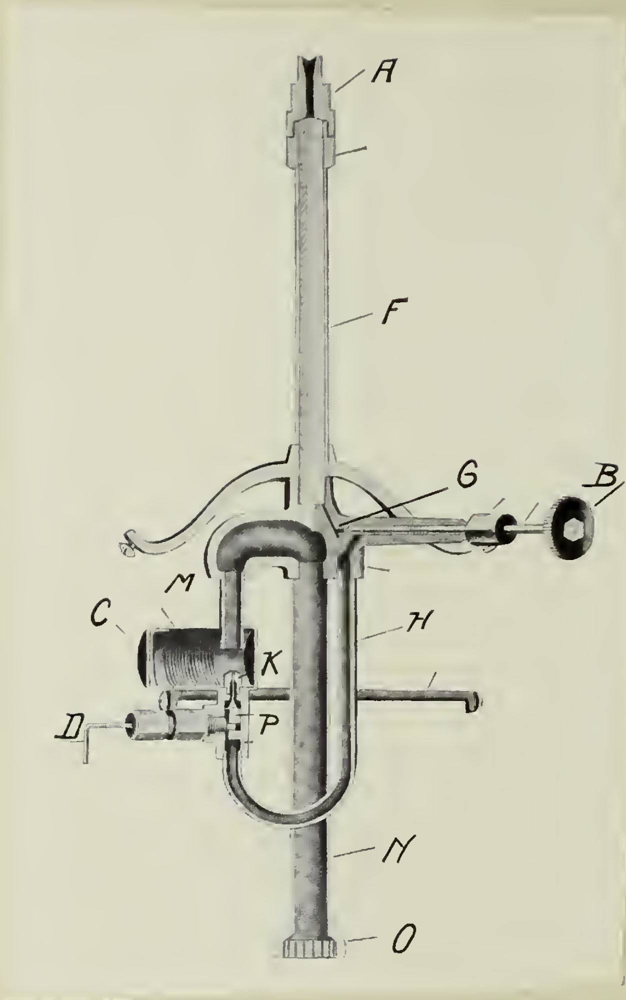
The screen S, which correspondssto the screen S, in figure 133, is quite as necessary as in the other lamp. It not only assures a uniform distribution of the gas in the tube but it prevents the mantle from being broken when the burner is lighted. If this screen is punctured, the rush of gas that takes

when the burner is lighted will be sufficient to blow out the bottom of the mantle. The burner tip T, is practically the same as that used with the other mantle lamps.

PORTABLE GASOLENE LAMPS- The portable form of desk and reading lamps for the use of gasolene is made in a great variety of styles. They are constructed to feed by gravity or by the pressure method and assume many forms of mechanism. The protable lamp must be a complete gas plant, with storage tank for the gasolene, pipe system for conducting the gasolene to the lamp, generator and burner. To give satisfactory results the lamp must be capable of being lighted with the least degree of trouble and operated with the least amount of care. The immense number of lamps of this kind that are sold, shows that they meet all of these requirments and have proven a satisfactory lamp. Their greatest attractiveness is their capability of giving a very large amount of light at relatively low cost.

Figure 139 illustrates a protable gasolene lamp in which a convenient and efficient form of generating mechanism is combined with an attractively proportioned exterior. The lamp works on the principle of the hollow-wire system, the base serving as a storage and pressure tank, the frame of the lamp acts as the tube for supplying the lamp with gasolene, and the canopy contains the generating mechanism.

The tank in the base is filled with gasolene at the opening L, which is made air tight by a screw plug. The plug also contains an attachment piece for the air-pump which furnished



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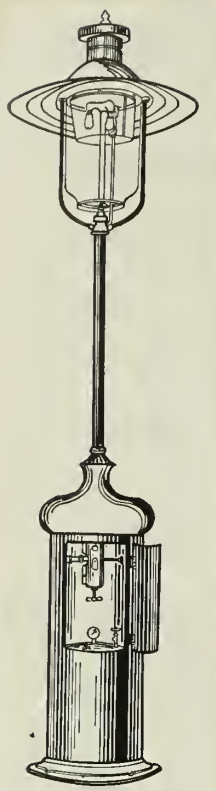
the pressure to the gasolene, as in the case of the hollow-wire lighting system. The hollow standard reaches to the bottom of the tank and through it the gasolene is forced to the point marked A, where the gasolene enters the generating mechanism. This part of the lamp which is entirely concealed by the lamp canopy is shown in detail in figure 140. The reference letters in figure 139 apply to the same parts in the detail drawing.

The gasolene enters the asbestus packed tube F, at the point A, and after percolating through the tube reaches the regulating valve at the point G.. The hand wheel E, opens and closes the valve which controls the entrance of the gasolene to the generating tube H, where it is converted into vapor. The vapor now awaits only the addition of air to make it the desired gas for illuminating the mantle.

The vapor from the generating tube escapes at the small hole K, located directly under the mixing chamber M. The supply of air is received through the tube C, provided with a regulator which is readily accessible from the out-side of the lamp. The mixture of gasolene vapor and air is conveyed through the Bunsen tube M, to the mantle attached to the tip O. to which the mantle is attached.

This lamp is provided with a special means of keeping the opening K, free from accumulations. The opening K, is a very small and any slight stoppage will interfere with the flow of the vapor and impair the illuminating effect of the light. A lever D, operates an eccentric carrying a pin which readily enters the open-



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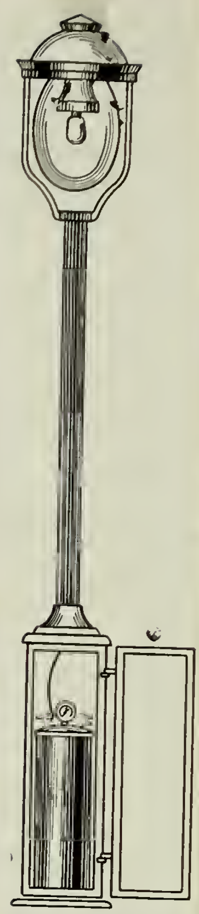

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ing K, when the lever is turned. Any accumulation which may lodge in the opening is instantly removed and the needle returned to its place by a turn of the lever D.

BOULEVARD LAMPS:- Gasolene lamps for outside illumination may be arranged with ~~all~~ any of the systems described but, the hollow-wire and the Generator systems are most conveniently used because each post may be arranged as an independent plant. For illuminating private grounds or public thoroughfares, lamps such as are illustrated in figures 141 and 142, are very generally used.

The lamp shown in figure 141, is of the generator type in which the storage tank and generator mechanism are ~~to~~ located in the base of the post. These lamps are also constructed with a clock that the light may be automatically extinguished at any desired time.

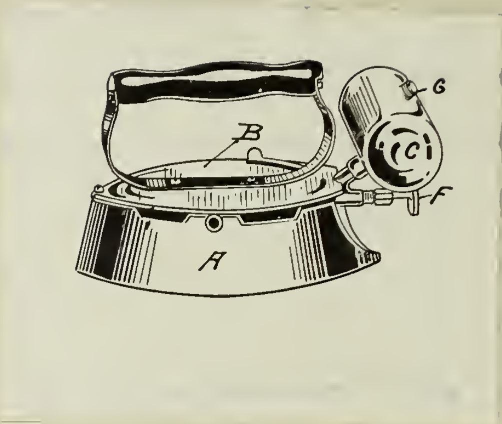
In figure 142, the lamp is of the hollow-wire type and as in the case of the other, the supply tank is in the base of the post. With this system it would be possible to supply several lamps from a common supply tank, provided the hollow-wire was protected against damage. The lamps arranged to work on either system require the same amount of attention and are subject to the same derangements as those for inside service.

GASOLENE SAD-IRONS:- The use of gasolene as a means of heating sad-irons has come into favor because of its convenience and economy in operation. These irons,- in common with the use of gasolene in its other applications of heating and lighting- are made in a great many forms but

the principle of operation is confined to two types. 1st- those in which the gasolene is forced into the generator by the vapor pressure from the heated supply-tank and 2nd.- those in which the pressure is caused by pumping air into the supply-tank after the manner of the Hollow-Wire system of lighting.

The first type of iron is illustrated in figure 143. The same iron is shown in figure 144. with the top in position for generating vapor ~~for~~ with which to starting the burner. The body of the iron A, is a hollow casting, designed to receive the generator and burner in such position that the bottom portion of the iron may be uniformly heated. The generator and burner are shown in detail in figure 145, in which a sectional view is given of the parts, cut across lengthwise ofthe iron.

In starting the burner for use, the tank is first filled not quite full-of strained gasolene. This precaution should be taken to prevent putting into the tank anything that will possible choke the needle valve. Alcohol is used for generating the vapor supply because the flame does not black the iron and fill the room with smoke as in the case when gasolene is used for the purpose. When the alcohol is ignited, the cover is placed in position as shown in figure 144, so that the flame not only heats the generator but also heats the tank. The object of heating the tank is that the heated gasolene may furnish pressure with which to force the gasolene into the generator. When the alcohol used for generating is almost burned out the valve F, is slightly opened and the



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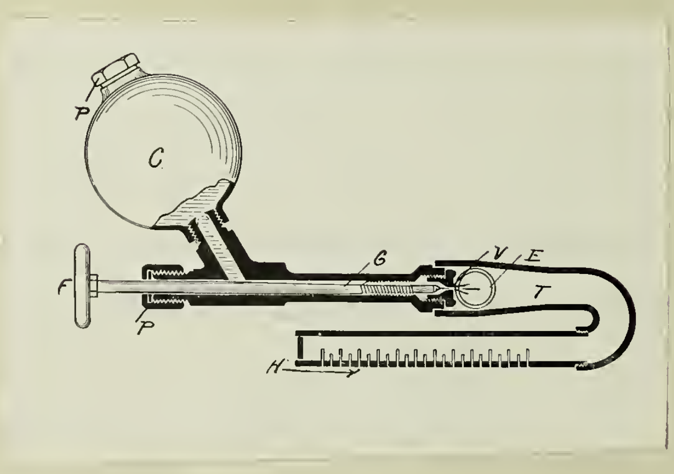

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and the burner is lighted.

As shown in figure 145, the generator G is a brass tube inclosing the valve-stem G, which terminates in the needle valve V, for regulating the heat of the burner and is operated by the handwheel F. When heated the necessary amount the gasolene vapor in G, is allowed to escape through the valve V. The vapor is discharged into the Bunsen tube and with it the air is carried in through the openings E, from both sides of the iron. The burner is a brass tube, slotted as shown at H, through which the gas escapes forming a short flame of large area, close to the part of the iron to be heated. The size of the flame is regulated by the handwheel F.

The tank is entirely closed, the plug P, being provided with a lead washer to insure a tight joint. The plug is further provided with a soft metal center which acts as a "safety-plug" in case of overheating. Should the iron at any time become too hot the soft metal center will melt and the released pressure in the tank will put out the burner flame. The soft metal center may be renewed with a drop of solder.

ALCOHOL SAD-IRONS:- Irons of the same style are also made in which alcohol is used as a fuel. The alcohol irons differ in construction from those using gasolene only in the amount of air that is mixed with the vapor. In general appearance the two styles look very much alike, but in the alcohol iron one of the intakes E, is entirely closed and the other opening is partially closed.

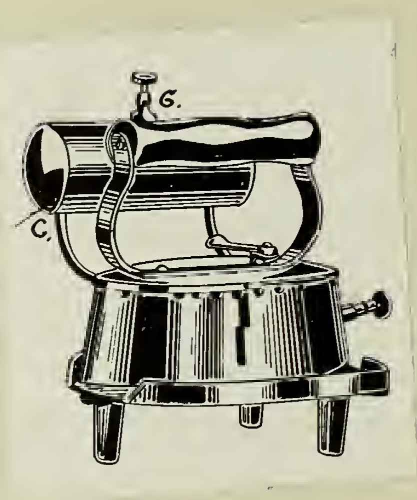
The operation of these irons is identical to those us-

heats the tank. The object of heating the tank is that ~~the~~ ~~alcohol~~ the heated gasolene may ~~vaporize and~~ furnish pressure, with which to ~~to~~ force the gasolene into the generator. When the alcohol used for generating is almost burned out the valve F, is slightly opened and the burner is lighted.

As shown in figure 145, the generator G, is a brass tube inclosing the ~~valvestem~~ valve-stem 6, which terminates in the needle valve V, for regulating the heat of the burner and is operated by the handwheel F. When heated the necessary amount, the gasolene vapor in G, ~~when~~ is allowed to escape through the valve V, ~~will~~ ~~instantly~~ ~~vaporize~~. The vapor is discharged into the Bunson tube and with it the air is carried in through the openings E, from both sides of the iron. The burner is a brass tube, slotted as shown at H, through which the gas escapes forming a short flame of large area, close to the part of the iron to be heated. The size of the flame is regulated by the handwheel F.

The tank is entirely closed, the plug P, being provided with a lead washer to insure a tight joint. The plug is further provided with a soft metal center which acts as a "safety-plug" in case of over-heating. Should the iron at any time become too hot the soft metal center will melt and the released pressure in the tank will put out the burner flame. The soft metal center may be renewed with a drop of solder.

Alcohol Sad-irons:- Irons of the same style are also made in which alcohol is used as a fuel. The alcohol irons differ ~~somewhat~~ in construction from those using gasolene ~~mainly~~ only in the amount of air that is mixed with the vapor. In general appearence the two styles look very much alike



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ing gasolene, but they are preferred by those who fear the use of gasolene. In reality there is little difference in the danger attending the use of the two fuels. It is only fair to say, however, that the use of any highly volatile fuel is attended with some danger when used carelessly but with a reasonable amount of care and a knowledge of the mechanism of the machine in use, the danger is of minor consequence.

In figure 146, is illustrated another style of gasolene sad-iron, the working principle of which is the same as those already described but the supply tank is not heated to give pressure to the gasolene in the tank. In this iron the tank is located at one side of the iron and pressure is applied with an air pump as in the hollow-wire system of lighting. The burner is generated after the manner of the others and operated in exactly the same manner. The chief difference is that the possibility of excessive pressure through over-heating is illiminated.

ALCOHOL TABLE STOVES:- In the United States the use of alcohol , as a fuel has never been extensively employed because of the duty imposed on its manufacture by the federal goverment. In 1896 this duty was removed from denatured alcohol and the cost was sufficiently reduced to permit a great extension in its use as a fuel.

Denatured alcohol is any alcohol to which has been added, any of the list of prescribed volatile fluids that will render the alcohol non-potable and not materially change its heating value. Denatured alcohol is sold at a

but in the alcohol iron one of the intakes E, is entirely closed and the other opening is partially closed.

The operation of these irons is identical to those using gasolene ~~alcohol~~ but they are ~~is~~ preferred in ~~use~~ by those who fear the use of gasolene. In reality there is little difference in the danger attending the use of the two fuels. It is anly fair to say, however that the use of any highly volatile fuel is attended with some danger when used carelessly but with a reasonable amount of care and a knowledge of the mechanism of the machine in use, the danger is of minor consequence.

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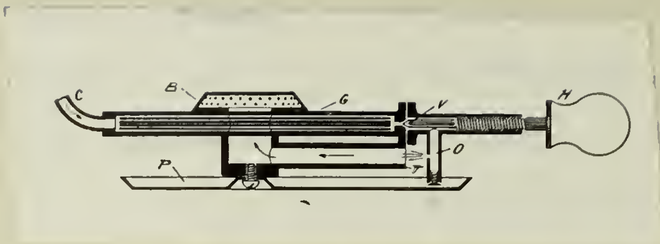

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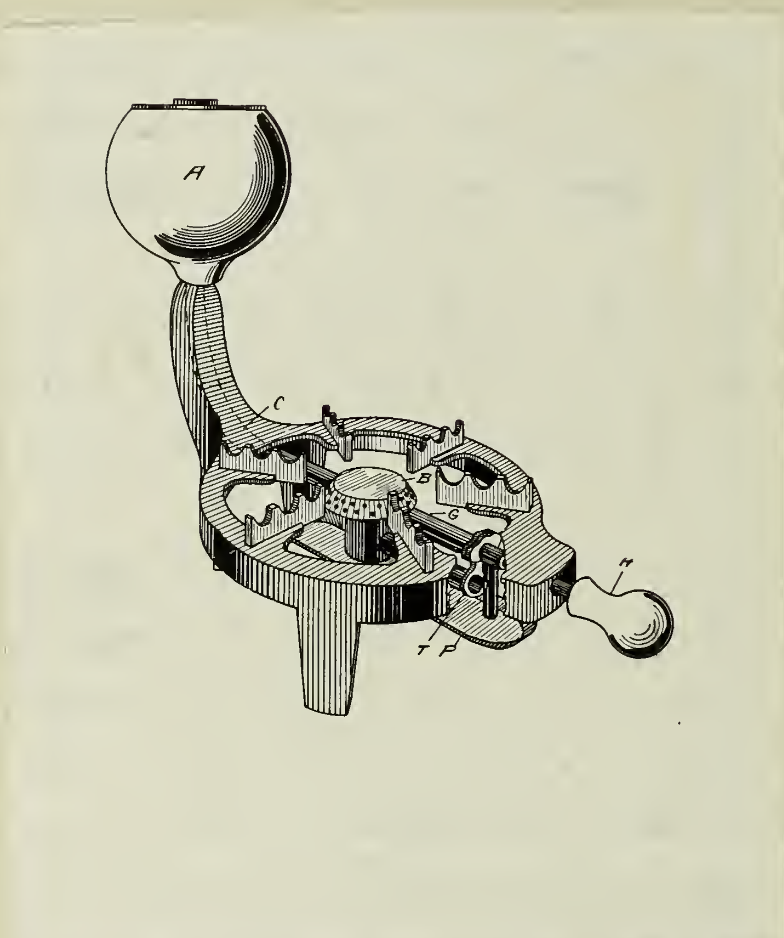

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price that will permit its use in small flat-irons, table-stoves and other forms of burners where convenience is of greater consequence than cost of fuel. At the price ~~of~~ de-natured alcohol is generally sold, it cannot compete with gasolene and kerosene as a fuel.

In figure 147, is shown a convenient and inexpensive form of table stove, inwhich the vapor of alcohol is burned in practically the same manner as the vapor of gasolene in the burners already described. The supply of alcohol is stored in a tank A, and fed by gravity to the burner B, the flame from which resembles that of the ordinary gasolene burner.

The generator G, with the other essential parts are shown in detail in figure 148. The reference letters indicate the same parts in the detail drawing as in the figure 146.

The alcohol flows from the supply tank through the pipe C, to the generator G, which is a brass tube filled with copper wires. The vapor for starting the burner is generated by opening the valve V, and allowing a small amount of alcohol to flow through the orofice O, into the pan P, directly below the generator. The valve is then closed and the alcohol ignited. When the generating flame has burned out the valve V, is again opened and the vapor which has generated in the generating tube, escapes at the orofice O, and enters the Bunsen tube T, carrying with it the proper amount of air to produce the Bunsen flame at each of the holes of the burner.

LIGHTING AND HEATING WITH GASOLENE.

As in the case of the gasolene burners the orifice O, sometimes becomes clogged and it is necessary to insert a small wire to clear the opening. With the stove is provided a tool for this purpose. With stoves of this kind the supply tank must not be tightly closed, because any pressure in the tank would cause it to become dangerous. The alcohol is fed to the generator entirely by gravity. The stopper of the tank contains a small hole at the top which should be kept open to avoid the generation of pressure should the tank become accidentily heated.

Stoves of this kind may be conveniently used for a great variety of household purposes and when intelligently handled are relatively free from danger.